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Home Bleaching Effects on the Surface Gloss, Translucency, and Roughness of CAD/CAM Multi-Layered Ceramic and Hybrid Ceramic Materials

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Abstract: The surface qualities of CAD/CAM multi-layered ceramic and hybrid ceramic materials are critical for superior aesthetics and may be impaired by the application of home bleaching. The aim of this study was to assess how home bleaching affects the surface gloss, translucency parameter (TP), and surface roughness (Ra, Rq, and Rz) of different CAD/CAM multi-layered ceramic and hybrid ceramic dental materials. The two types of innovative ceramics that were tested are ultra-translucent multi-layered (UTML) zirconia and polymer-infiltrated ceramic blocks. The samples were treated using home bleaching agents. Each specimen was tested under bleached and non-bleached conditions. The surface gloss and TP of the specimens were measured using a spectrophotometer. The surface examination was performed using scanning electron microscope (SEM) images, while the average surface roughness values (Ra, Rq, and Rz) were calculated using three-dimensional SEM images obtained by an imaging analysis system. A total of 120 disc-shaped resin composite specimens was distributed randomly according to each material in two main groups ($n = 60$): a control group immersed in 20 mL distilled water (non-bleached) ($n = 30$), and a second group treated with 20 mL of a home bleaching agent (Crest 3D White Multi-Care Whitening Mouthwash) for 60 s, twice daily for seven days (bleached) ($n = 30$). The surface gloss, TP, and surface roughness ($n = 10$ per test for each group) of each group (bleached and non-bleached) was tested. An independent sample t-test was used statistically to assess the effect of home bleaching on the surface gloss, translucency, and roughness of each ceramic material and to compare the two materials. The significance level was adjusted at $p \leq 0.05$. The results of the bleached UTML specimens showed no significant changes regarding surface gloss, TP, and roughness, whereas the bleached Vita Enamic specimens showed a significant reduction in surface gloss and TP and increased surface roughness. Moreover, the UTML specimens showed a significantly higher initial surface gloss and TP, and a reduced surface roughness, contrary to the Vita Enamic specimens. This study concluded that surface gloss retention, translucency, and surface roughness could be negatively influenced when subjected to home bleaching according to the type and composition of the ceramic materials.

Keywords: bleaching; CAD/CAM ceramic; hybrid ceramic; gloss; translucency; roughness

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1. Introduction

Advancements in dental ceramics comprise improvements in their structural strength and optical properties to provide a dental restoration with high strength, aesthetic qualities, and long durability. Dental ceramics are divided into three categories based on their composition: glass matrix, polycrystalline, and resin-modified ceramics [1,2]. The fabrication of ceramic and composite esthetic materials in dentistry via computer-aided design/manufacturing (CAD/CAM) technology has continuously improved, permitting a reliable and predictable procedure for the restoration of single or multiple units [3,4].

The process of bleaching can be carried out in the office using a higher concentration of the active ingredient, such as hydrogen peroxide, or at home using kits that contain lower concentrations of hydrogen peroxide. The diffusion of the active ingredient happens more quickly and can be more harmful to pulpal tissues at higher concentrations. Home bleaching uses a lower concentration of the active ingredient; therefore, it has gained great popularity among patients. The concentration of hydrogen peroxide in the bleaching materials can range from 1.5% to 40% [5]. Higher concentrations permit a more significant release of H^+ or H_3O, followed by possible radical diffusion, which may decrease the surface gloss of ceramics via the dissolution of ceramic glass networks [6].

The impact of home bleaching treatments on the restorative materials adjacent to the teeth being bleached should not be ignored. Even though such treatments are commonly used for bleaching natural teeth, there are limited data about the effect of home bleaching on these recently introduced ceramic dental materials. There are no available data about the effect of home bleaching on the surface gloss, TP, and surface roughness of newly introduced CAD/CAM ultra-translucent multi-layered zirconia and multi-layered hybrid ceramic materials.

The aim of the current study was to assess the effect of home bleaching on the surface gloss, TP, and surface roughness of different CAD/CAM multi-layered ceramic and hybrid ceramic dental materials. The two types of innovative ceramics that were tested are ultra-translucent multi-layered (UTML) zirconia and polymer-infiltrated ceramic (hybrid ceramic) blocks.

Zirconia has several advantages, such as a natural appearance that is acceptable, great biocompatibility, unique strength, and a high level of resistance to wear and corrosion in the oral environment. Despite this, zirconia has significant intrinsic disadvantages that limit its use in highly aesthetic applications, such as its opacity and grayish-white color. To overcome these issues, a CAD/CAM multi-layered ceramic design was introduced to mimic the shade gradient seen in natural teeth. The microstructural architecture and composition were altered to enhance translucency, with the crown's incisal portion being the most translucent, increasing in opacity and chroma as it approaches the gingival area [7].

Monolithic zirconia with high translucency, multiple layers and a natural gradient shade is referred to as ultra-translucent multi-layered (UTML) zirconia. It is mainly based on a cubic zirconia construction [8]. It is considered the most preferred material for the production of anterior fixed dental prostheses. UTML zirconia is more appropriate for use in veneers, inlays, onlays, and anterior crowns [9]. Katana (Kuraray Noritake, Japan) was the first multi-layered zirconia system available for dental use [7].

Polymer/ceramic hybrid composites, compared with traditional materials, make it possible to customize the characteristics that each component can provide. Polymers are an example of a material with better ductility and a lower elastic modulus, while ceramic materials provide outstanding mechanical, biomechanical, and tribological qualities and high temperature stability. Consequently, the creation of polymer-infiltrated ceramic composites (hybrid ceramic) that allow the functionality of specific components to be customized presents potential for dental materials. The molecular mixing of a polymer and ceramic can be used to improve the polymer's strength while mitigating the brittleness of the ceramic. In terms of microstructure, it exhibits an inorganic ceramic matrix that is completely interpenetrated with an organic polymeric substance [10].

For all-ceramic systems, Vita Enamic is the preferred material due to its distinct mechanical and optical characteristics. Vita Enamic is recommended for use on both natural teeth and dental implants for minimally invasive dental restorations, including veneers, inlays, onlays, partial crowns, and anterior and posterior crowns [11].

The surface gloss and translucency parameter (TP) are two visual characteristics that affect how restorations look to resemble natural teeth [12]. Surface gloss is a crucial property that determines how much light is reflected off the surface and influences how shiny the surface appears [13]. Surface topography substantially influences gloss. However, various aspects, including the material's refractive index and the incident light's angle, also have a consequential effect [14]. It is crucial for an aesthetic restorative material to have a gloss value similar to or comparable to the tooth structure [15,16]. The quantity of light that may travel through a material defines its translucency, which lies between full transparency and opacity [17]. The surface features of the material, such as surface roughness, also affect its optical qualities. Because it affects the amount of light reflected, the restorative material's surface roughness has a significant impact on how it looks. An uneven or diffuse pattern reflected by a rough surface will change the restoration's color [12]. The null hypothesis was that (1) home bleaching would have no effect on a CAD/CAM multi-layered ceramic and hybrid ceramic regarding surface gloss, translucency, and roughness, and that (2) there would be no difference between the CAD/CAM multi-layered ceramic and hybrid ceramic regarding the initial surface gloss, translucency, and roughness.

2. Materials and Methods

Two types of innovative indirect multi-layered CAD/CAM restorative materials with different compositions and unique properties were investigated and tested for their surface gloss, translucency, and surface roughness after exposure to the home bleaching agent. The commercial ceramics were ultra-translucent multi-layered (UTML) zirconia, and polymer-infiltrated ceramic (hybrid composite) blocks; the samples were created in slices approximately 1 mm thick. The control group was immersed in 20 mL of distilled water (pre-bleaching) (n = 30). Meanwhile, the second group was treated with 20 mL of home bleaching agent (Crest 3D White Multi-care whitening mouthwash) for 60 s twice daily for seven days (post-bleaching) (n = 30). Each specimen was tested and investigated before and after exposure to the bleaching agent (pre- and post-bleaching). The surface gloss and TP of the specimens were measured using a spectrophotometer. The surface examination was observed using scanning electron microscope (SEM) images. While the average surface roughness values (Ra), root mean square roughness (Rq), and the difference between the highest point and the lowest point in the image (Rz) were calculated using three-dimensional SEM images obtained using an imaging analysis system. Table 1 contains a list of the commercial materials used in this investigation.

Table 1. The manufacturer's data of the materials used in the study.

Material Name	Type of Material	Chemical Composition	Manufacturer
Crest 3D White Multi-Care Whitening Mouthwash	Home bleaching agent	Water, 1.5% Hydrogen peroxide, propylene glycol, sodium hexametaphosphate, poloxamer 407, sodium citrate, flavor, sodium saccharin, citric acid	Procter & Gamble, Cincinati, OH, USA
Katana Ultra Translucent Multi Layered (UTML)	Zirconia	87–92% ZrO_2, 8–11% Y_2O_3, Other < 2%.	Kuraray Noritake Dental Inc., Tokyo, Japan.
VITA ENAMIC	Polymer infiltrated ceramic	Fine structure feldspar ceramic (86% wt.): SiO_2 (58% 63%), Al_2O_3 (20%–23%), Na_2O (6%–11%), K_2O (4%–6%), B_2O_3 (0.5%–2%), CaO (<1%), TiO_2 (<1%). Polymers (14% wt.): UDMA and TEGDMA.	VITA Zahnfarik, Bad Sackingen, Germany.

2.1. Sample Size Calculation

The data used to calculate the sample size considered the surface gloss, translucency, and surface roughness; based on these, the highest sample size was chosen. We used G*Power 3.1.9.7 software analysis (G*Power, Heinrich-Heine-Universität Dusseldorf, Dusseldorf, Germany) to perform the power analysis and calculate the sample size. A standard sample size calculation was performed according to previous studies conducted by Alkurt et al. [18]. With an alpha of 0.05, a power of 0.85 (85%), and a medium effect size of 0.5, the sample size calculated for this study was 10 samples in each group ($n = 10$).

2.2. Study Design

A total of 120 specimens (60 specimens each material) were produced by cutting the blocks of the CAD/CAM multi-layered ceramic material into slices. The specimens were evenly distributed into two groups (bleached and non-bleached) of 30 specimens. These were divided into three subgroups of specimens ($n = 10$) for the examination of surface gloss, translucency parameter (TP), and surface roughness (Figure 1).

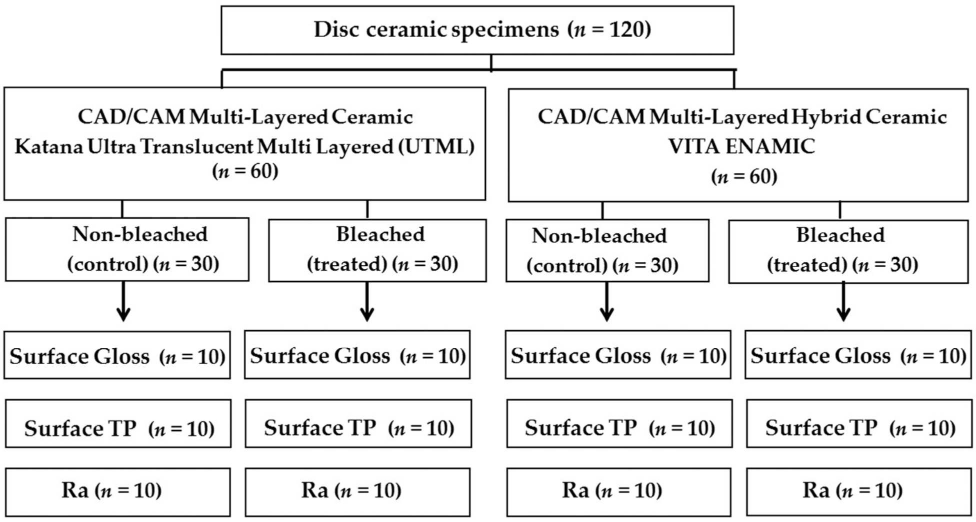


Figure 1. Group distribution.

2.3. Specimen Preparation

Using CAD/CAM technology (group LU, Lava Ultimate A2 LT 3M USA, Saint Paul, MN, USA), the ceramic specimens were created in accordance with the manufacturer's instructions [19]. The specimens were standardized in the form of flat slices measuring 15 mm in length, 15 mm in width and 1 mm thick, with a shade of A2 (Figure 1). All specimens were stored in a separate container filled with distilled water at 37 °C for 7 days in an incubator (CBM, S.R.L. Medical Equipment, 2431/V, Cremona, Italy) before starting the treatment.

The two CAD/CAM multi-layered ceramic materials used in the study were CAD/CAM multi-layered ultra-translucency zirconia (KATANA, Zirconia Multilayered Disc, Noritake Dental Supply Co., Japan) and CAD/CAM multi-layered hybrid ceramic (VITA ENAMIC, VITA Zahnfarik, Bad Sackingen, Germany).

The specimens of each CAD/CAM multi-layered ceramic material were randomly divided into two main groups ($n = 60$). One group acted as a control (non-bleached) while the other groups were treated with the bleaching agents (bleached). The control groups were subjected to immersion in 20 mL of distilled water for 60 s twice daily for seven days ($n = 30$). The treated groups were subjected to immersion in 20 mL of home bleaching agent (Crest 3D White Multi-Care Whitening Mouthwash, Procter & Gamble, Cincinati, OH, USA) for 60 s twice daily for seven days ($n = 30$). Prior to every bleaching process, the samples were removed from the distilled water and dried using gauze.

All specimens were rinsed with distilled water for one minute following each bleaching process to remove the bleaching substance. The specimens were stored in the incubator at 37 °C between each bleaching cycle.

2.4. Measuring Procedures

2.4.1. Surface Gloss Measurement

The measurement of the surface gloss was performed using a glossmeter (ZGM 1130, Zehntner GmbH Testing Instruments, Sissach, Switzerland). A laser beam aimed at a 60° angle was applied to each specimen's surface to assess the gloss [20]. The light reflected at the same angle was then measured. Prior to measuring the gloss, the apparatus was calibrated using a black glass provided by the manufacturer, which had a reference value of 93.7 gloss units (GU). The specimens were put on the top plate of the glossmeter and covered with a black cover during the gloss measurement process to protect them from exposure to outside light. Five measurements were performed at the center of each specimen, from which the mean value for each was determined. Gloss measurements were performed.

2.4.2. Translucency Measurement

Translucency is a visual evaluation of a material's capacity to mask, or how much it permits the underlying background to show through. The following calculation was used to calculate the color differences for the same specimen thickness compared to black and white backgrounds to obtain the translucency parameter (TP):

$$TP = [(L^*_b - L^*_w)^2 + (a^*_b - a^*_w)^2 + (b^*_b - b^*_w)^2]^{1/2}$$

where the values of the specimens on the black and white backgrounds are denoted by b and w, respectively; L* represents lightness; a* represents the green (–a) and red (+a) axes; and b* represents the blue (–b) and yellow (+b) axes [21].

2.4.3. Surface Roughness Measurement

The surfaces roughness was investigated using scanning electron microscopy (Model Quanta 250 FEG, FEI company, Eindhoven, The Netherlands) with 2000× magnification [22,23]. The SEM micrograph was then used to examine the surface roughness of the same specimens [24–26]. Using the imaging analysis system Scandium Solution Height (Olympus Soft Imaging Solutions, GMBH, Münster, Germany), SEM pictures were transformed into three-dimensional images. Every specimen's average surface roughness values (Ra) were noted.

2.5. Statistical Analysis

The mean and standard deviation were used to express the findings. Statistical Package for the Social Sciences (12.0, SPSS Inc., IBM, Chicago, IL, USA) was used to conduct the statistical analysis. The normality test was performed using the Shapiro–Wilk and Kolmogorov–Smirnov tests. An independent sample *t*-test was used to investigate the effect of bleaching on the surface gloss, translucency, and surface roughness of each material (UTML and Vita Enamic). It was also used to compare the two materials. The significance level was adjusted at $p \leq 0.05$.

3. Results

3.1. The Surface Gloss Results

The mean surface gloss values of the bleached and non-bleached ceramic materials are displayed in Table 2. There was no significant change in the surface gloss of UTML after bleaching ($p = 0.5$), contrary to Vita Enamic, which showed a reduction in the gloss after bleaching ($p = 0.00001$). Comparing the two materials, UTML had higher gloss levels than Vita Enamic ($p = 0.00001$).

Table 2. Mean surface gloss values for the two materials when either non-bleached or bleached.

Surface Gloss	Non-Bleached (Control)	Bleached	*p* Value
UTML	48.6 ± 0.8	48.5 ± 0.3	0.5
VITA ENAMIC	43 ± 0.1	42.5 ± 0.1	0.00001 *
p Value	0.00001 *	0.00001 *	

*: significant ($p < 0.05$).

3.2. The Translucency Parameter Results

The mean TP values of the bleached and non-bleached ceramic materials are displayed in Table 3. The was no significant change in the translucency of UTML after bleaching (p = 0.4); this is compared to Vita Enamic, which showed a reduction in translucency after bleaching (p = 0.00001). Comparing the two materials, Vita Enamic showed higher translucency than UTML (p = 0.00001).

Table 3. Mean values of translucency for the two materials when either non-bleached or bleached.

TP	Non-Bleached (Control)	Bleached	*p* Value
UTML	11.4 ± 0.01	11.03 ± 0.02	0.4
VITA ENAMIC	15.7 ± 0.03	15 ± 0.04	0.00001 *
	0.00001 *	0.00001 *	

*: significant ($p < 0.05$).

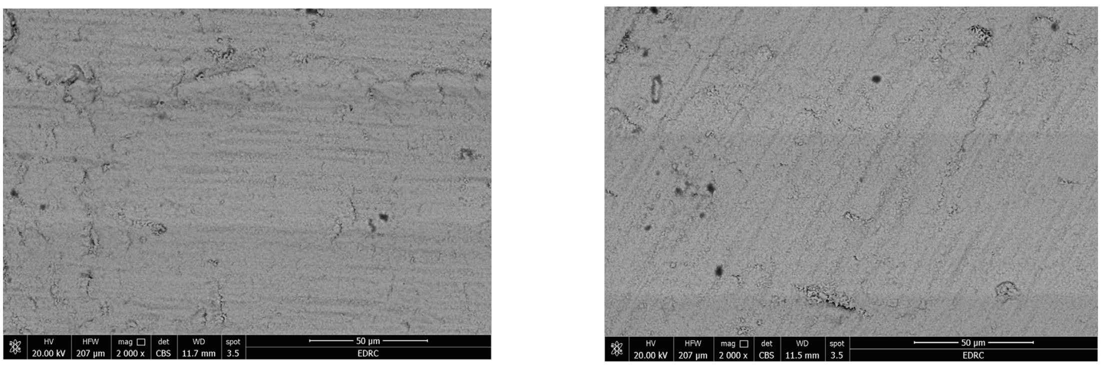
3.3. The Surface Roughness Results

The mean, standard deviation values of the SEM surface examination images and 3D surface roughness (Ra, Rq, and Rz) are presented in Table 4. A representative SEM micrograph of the non-bleached or bleached specimens is presented in Figures 2 and 3.

Table 4. Mean values of surface roughness (Ra, Rq, and Rz) (µm) for the two materials when either non-bleached or bleached.

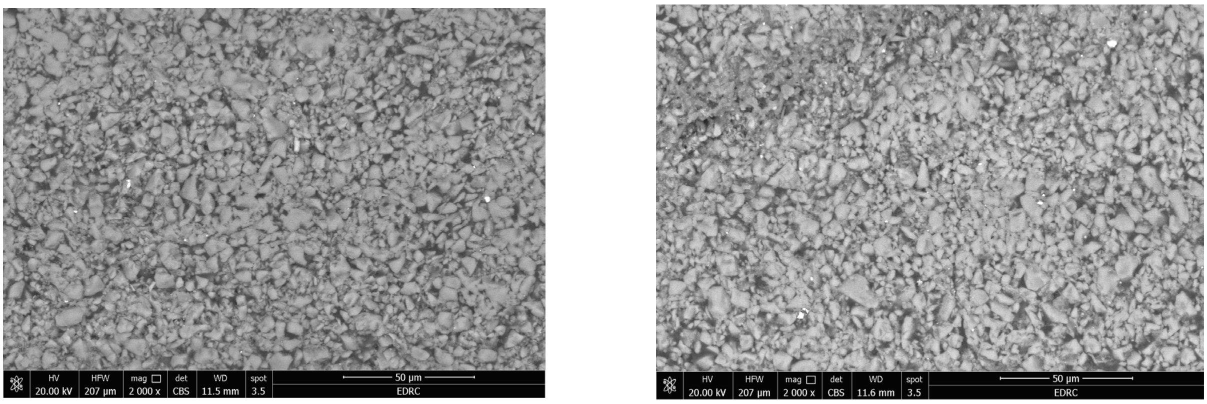
Dental Ceramic	Non-Bleached (Control)	Bleached	*p* Value
UTML	Ra = 0.0106 ± 0.00002	Ra = 0.0107 ± 0.0003	0.5
	Rq = 0.0141 ± 0.0001	Rq = 0.0142 ± 0.0002	0.2
	Rz = 0.154 ± 0.003	Rz = 0.155 ± 0.0005	0.6
VITA ENAMIC	Ra = 0.0226 ± 0.00008	Ra = 0.02514 ± 0.00002	0.00001 *
	Rq = 0.0277 ± 0.00002	Rq = 0.0308 ± 0.00001	0.00001 *
	Rz = 0.1808 ± 0.00002	Rz = 0.1938 ± 0.00023	0.00001 *
***p*Value between both materials (Ra, Rq, Rz)**	0.0001 *	0.0001 *	

*: significant ($p < 0.05$).



(**a**) (**b**)

Figure 2. Representative SEM micrographs of UTML specimen at 2000× magnification when (**a**) non-bleached and (**b**) bleached.



(**a**) (**b**)

Figure 3. Representative SEM micrographs of VITA ENAMIC specimen at 2000× magnification when (**a**) non-bleached and (**b**) bleached.

The was no significant change in the surface roughness (Ra, Rq and Rz) of the UTML after bleaching (p = 0.5, 0.2 and 0.6, respectively). This is contrary to Vita Enamic, which showed an increase in the surface roughness (Ra, Rq and Rz) after bleaching (p = 0.00001). Comparing the two materials, UTML showed lower surface roughness (Ra, Rq and Rz) than Vita Enamic (p = 0.00001).

Moreover, the SEM micrograph showed the homogenous, non-porous surface of both bleached and non-bleached specimens. There was no obvious surface roughness detected in the SEM images.

4. Discussion

The aim of the present study was to assess how home bleaching affected the surface gloss, TP, and surface roughness of different CAD/CAM multi-layered ceramic and hybrid ceramic dental materials.

Bleaching treatments may alter the structure and physical characteristics of dental restoration, which could result in early failure [27]. The distribution of light across an object's surface through absorption, scattering, and reflection is known as gloss [28]. Surface gloss is an important surface characteristic that indicates how much incident light is reflected from the surface, which determines how shiny the surface is [29]. The gloss retention of dental restorative materials is a crucial factor that affects the clinical longevity of esthetic restorations [30]. The surface gloss of the restorative materials is affected by the type, load, and distribution of inorganic fillers, as well as the thickness and refractive index of the materials [31]. Moreover, reduced gloss is impacted by the polymeric matrix [32]. The surface gloss decreases as the surface becomes rougher, indicating a less specular reflection and more diffused light [33]. A spectrophotometer can determine the specimen's spectral reflectance. Thus, it is possible to evaluate the surface gloss [34,35].

Material translucency is frequently described by the translucency parameter (TP) [12]. The translucency parameter (TP) is an optical characteristic that affects how restorations seem to mimic natural teeth [15]. It evaluated by measuring the color difference between the reflected colors of a material at a specific thickness when contrasted with a black and white background [13]. Either the CIELab formula or the CIEDE2000 formula can be used to calculate it [18,36]. The translucency of a material increases in proportion to its light transmittance. Several factors, including the particle size and density, crystalline structure, substance type, pigment, opacity, porosity, and oxygen space distribution, affect translucency [18].

The clinical success and longevity of dental materials are significantly influenced by their surface quality [37]. The surface roughness of dental restorations influences their optical properties, plaque accumulation, and restoration longevity [38]. An increase in the surface roughness value of than 0.2 µm, which represents the threshold Ra value for dental materials [39,40], might cause a change in the material's surface features and topography, with subsequent alterations in the color and surface gloss of the restoration; it can also increase the risk of periodontal inflammation by increasing the deposition of plaque [41].

The evaluation of surface roughness was performed by microscopic image analysis software to provide a comprehensive view of the surface [24,26]. Thus, in this study, it was more suitable than using an Atomic Force Microscope (AFM). The AFM scans only a smaller area and provides data at the nanoscale level, which could not be compared to the clinical critical value that was reported in the literature (0.2 μm) [41,42].

The bleaching agent and the surface of ceramic materials may interact differently depending on the structural and chemical composition of the CAD-CAM ceramic material [43]. The surfaces of dental ceramics may show surface degradation when exposed to H^+ or peroxide free radicals, even though they are typically thought of as inert materials. Therefore, the ceramics may change if exposed to hydrogen peroxide over an extended period [44]. CAD-CAM restoration materials based on ceramic and hybrid materials have been developed with varying chemical compositions and characteristics, and their application has expanded [45]. Recently, UTML zirconia and polymer-infiltrated ceramic blocks were introduced to enhance the aesthetic demands of dental ceramics.

Crest 3D White Multi-Care Whitening Mouthwash was chosen as a popular whitening agent due to its easy application, affordable cost, and widespread availability. This substance is typically used to remove stains from tooth surfaces using a lower concentration of hydrogen peroxide and sodium hexametaphosphate than other whitening agents [46]. Additionally, Katana Ultra Translucent Multi Layered was chosen for this study because, according to the manufacturer, it is a highly translucent CAD-CAM restoration material made entirely of a cubic system, offering exceptional optical qualities and long-term durability [47]. Furthermore, VITA ENAMIC was chosen because it is a durable, highly translucent resin-modified hybrid ceramic that is created by infiltrating a monomer mixture into a network of pre-sintered ceramic [48]. According to previous reports, the combination of ceramic and polymer phases offers these materials a hardness and stability that are comparable to that of natural dentition [49,50].

The chemical composition and material types of the used CAD/CAM ceramic materials are greatly different, as described previously in Table 1. Katana Ultra Translucent Multi Layered is monolithic partially stabilized zirconia (PSZ) composed of a 100% cubic system and 5% mol yttria. The cubic monophasic zirconia provides a high gloss appearance and improved optical properties [51]. Meanwhile, Vita Enamic is a hybrid ceramic based on feldspar ceramic (75% by volume, 86 wt.%), infiltrated by a cross-linked polymeric matrix (25% by volume, 14 wt.%). The amorphous polymeric part provides a high degree of translucency. Moreover, the infiltration of resin into the ceramic was performed to enhance the strength of the polymer and decrease the brittleness of the ceramic [15].

The null hypothesis was rejected, as the application of home bleaching showed a significant reduction in surface gloss and translucency and an increase in the surface roughness of the CAD/CAM multi-layered hybrid ceramic. Meanwhile, there was no significant difference in the CAD/CAM multi-layered ceramic. In addition, there was a significant difference between the initial surface gloss, translucency, and roughness between the tested CAD/CAM multi-layered ceramic and hybrid ceramic.

The results showed that home bleaching application leads to a significant reduction in the surface gloss of the VITA ENAMIC, while having no effect on the UTML. A potential explanation for the reduction in surface gloss following home bleaching application is the hydrolysis and degradation of the polymeric resin [52]. In addition, the gloss of the hybrid ceramic, which is composed of resin composite materials, deteriorates promptly when compared to ceramics [53]. Moreover, ceramics displayed a higher initial gloss and gloss retention compared to the VITA ENAMIC hybrid ceramic mainly due to the presence of monolithic zirconium dioxide in the UTML ceramics [33,53]. Furthermore, the results may be attributed to the high chemical stability of the polycrystalline ceramics compared to glassy and polymer matrix ceramics [15].

The results also revealed a significant reduction in the translucency of the VITA ENAMIC, while the application of home bleaching had no effect on the UTML. These findings may be attributed to the polymer matrix in the resin-infiltrated hybrid ceramic being deteriorated by the action of the hydrogen peroxide [43]. On the other hand, the stability of the translucency in the UTML ceramic upon bleaching may be attributed to its composition, as it is composed of densely packed crystals of zirconia without a glassy matrix [43,54]. Moreover, the results showed the higher initial translucency of the VITA ENAMIC compared to UTML. The reduced translucency of the Katana may be due to its chemical composition, where the polycrystalline ceramics are packed densely with zirconia [54]. On the other hand, the cause of the increased translucency of the VITAIC may be the amorphous nature of polymer-infiltrated resin ceramics, mainly due to the resinous matrix [49].

The results showed that home bleaching application leads to a significant increase in the surface gloss of VITA ENAMIC. However, clinically, this is considered as insignificant as the results were within the acceptable range (<0.2 μm) [43,55]. These findings may be due to the effect of the bleaching agent on the polymeric matrix [15]. This variation is probably caused by the resinous component of the VITA ENAMIC hybrid ceramic having less hardness than materials based on ceramics only [56]. Furthermore, the results exposed an initial decrease in the surface roughness of the UTML compared with VITA ENAMIC. The initial reduction in the roughness of UTML may be attributed to the presence of zirconia nanoparticles [55]. Meanwhile, in hybrid ceramic materials, the higher resin content may be the cause of the initial increase in the surface roughness [57].

The results of the present study agreed with the study conducted by Alshali et al., which reported that the surface gloss and roughness of the polymer-infiltrated ceramic were adversely affected by the employment of 20 or 35% carbamide peroxide as a home bleaching agent [15]. Also, these results accord with the investigation carried out by Popescu et al., which reported that the surface roughness of different resinous-based restorative materials after the application of office bleaching with 40% hydrogen peroxide or home bleaching with 16% carbamide peroxide is affected [27]. Furthermore, our finding agreed with the results reported by Sonmez et al., which showed that the initial surface and mechanical properties of the ceramic–polymer composite were lower than those of ceramic-based materials [49]. Additionally, our findings are consistent with another study by Geduk et al. that demonstrated that whitening toothpastes render resin-based materials rougher than ceramic-based materials [58]. Moreover, our results confirm the results obtained by Yalcinet al., who concluded that the gloss retention is highly affected by the type of material when different types of bleaching agent are applied [59].

However, our results partially agree with the findings of Çölgeçen et al., who found that the application of 16% carbamide peroxide home bleaching led to an increase in the surface roughness of both ceramic-based CAD-CAM and hybrid materials after home bleaching with 16% carbamide peroxide [43]. These contradictions may be attributed to the lower percentage of the home bleaching used in our study, where about 1.5% hydrogen peroxide is not enough to deteriorate the highly stable ceramic-based CAD-CAM but could destructively affect the resin matrix of the hybrid ceramic materials [60].

On the other hand, compared to the results of the study performed by Alrabeah et al., we found that the application of 15% carbamide peroxide home bleaching affects the optical properties and surface texture of translucent zirconia [16]. Moreover, Aalkurt et al. found that a home bleaching agent with 10% carbamide peroxide and 6% hydrogen peroxide negatively affected the color and translucency of CAD/CAM monolithic zirconia [18]. Such discrepancies may also be attributed, as previously described, to the lower concentration of hydrogen peroxide used in the current home bleaching protocol [60].

This study displays the inherent limitations of an in vitro examination because other variables may have clinically caused alterations in the surface gloss, transparency, or roughness of the ceramic restorations. Other factors like salivary dilution and additional oral environmental elements such as heat change could affect the bleaching agent. Furthermore, further studies could be performed to examine the effect of toothbrushing and thermocycling. Moreover, it is advised that investigations are conducted over extended periods and using different formulas and concentrations of home bleaching agents. Additionally, further studies are recommended to investigate the possible effect on the abrasion resistance and chemical resistance of the tested ceramics.

5. Conclusions

Considering the circumstances of the current in vitro investigation, the surface gloss retention, translucency, and surface roughness could be negatively influenced when subjected to home bleaching according to the type and composition of the ceramic materials. The initial surface gloss retention, translucency, and surface roughness appear to be influenced by the type of ceramic material. The results of this study indicate that when hybrid ceramic restorations are present in the mouth, hydrogen peroxide home bleaching should be avoided.

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References

1. Alhotan, A.; Alhijji, S.; Abdalbary, S.A.; Bayoumi, R.E.; Matinlinna, J.P.; Hamdy, T.M.; Abdelraouf, R.M. An Advanced Surface Treatment Technique for Coating Three-Dimensional-Printed Polyamide 12 by Hydroxyapatite. *Coatings* **2024**, *14*, 1181. [CrossRef]
2. Gracis, S.; Thompson, V.; Ferencz, J.; Silva, N.; Bonfante, E. A New Classification System for All-Ceramic and Ceramic-like Restorative Materials. *Int. J. Prosthodont.* **2016**, *28*, 227–235. [CrossRef] [PubMed]
3. Jovanović, M.; Živić, M.; Milosavljević, M. A Potential Application of Materials Based on a Polymer and Cad/cam Composite Resins in Prosthetic Dentistry. *J. Prosthodont. Res.* **2021**, *65*, 137–147. [CrossRef] [PubMed]
4. Spitznagel, F.A.; Boldt, J.; Gierthmuehlen, P.C. CAD/CAM Ceramic Restorative Materials for Natural Teeth. *J. Dent. Res.* **2018**, *97*, 1082–1091. [CrossRef]
5. Gasmi Benahmed, A.; Gasmi, A.; Menzel, A.; Hrynovets, I.; Chirumbolo, S.; Shanaida, M.; Lysiuk, R.; Shanaida, Y.; Dadar, M.; Bjørklund, G. A Review on Natural Teeth Whitening. *J. Oral Biosci.* **2022**, *64*, 49–58. [CrossRef]
6. Morkūnaitė, G.; Ožiūnas, R.; Čeplauskas, V.; Tučkutė, S.; Laurikaitienė, J.; Adlienė, D. Surface Morphology Changes of Bleached Dental Ceramics. *Appl. Sci.* **2022**, *12*, 4557. [CrossRef]
7. Kolakarnprasert, N.; Kaizer, M.R.; Kim, D.K.; Zhang, Y. New Multi-Layered Zirconias: Composition, Microstructure and Translucency. *Dent. Mater.* **2019**, *35*, 797–806. [CrossRef]
8. Pongtongkham, P.; Pleumsamran, N.; Suttiat, K. Effect of CAD/CAM Position and Thickness of Ultra-Translucent Multilayered Zirconia on Color Aspects. *Int. J. Dent.* **2023**, *2023*, 5000800. [CrossRef]
9. Khosravani, S.R.; Kahnamoui, M.A.; Kimyai, S.; Navimipour, E.J.; Mahounak, F.S.; Azar, F.P. Final Colour of Ultratranslucent Multilayered Zirconia Veneers, Effect of Thickness, and Resin Cement Shade. *Biomed. Res. Int.* **2022**, *2022*, 2555797. [CrossRef]
10. Manziuc, M.; Khechen, A.A.; Negucioiu, M.; Poiană, I.; Kui, A.; Mesaroș, A.; Buduru, S. Survival Rates of Glass versus Hybrid Ceramics in Partial Prosthetic Restorations: A Scoping Review with Emphasis on Adhesive Protocols. *J. Clin. Med.* **2023**, *12*, 6744. [CrossRef]
11. Bajraktarova-Valjakova, E.; Korunoska-Stevkovska, V.; Kapusevska, B.; Gigovski, N.; Bajraktarova-Misevska, C.; Grozdanov, A. Contemporary Dental Ceramic Materials, a Review: Chemical Composition, Physical and Mechanical Properties, Indications for Use. *Open Access Maced. J. Med. Sci.* **2018**, *6*, 1742–1755. [CrossRef] [PubMed]
12. Silva, F.P.; Vilela, A.L.R.; Almeida, M.M.G.; Oliveira, A.R.F.; Raposo, L.H.A.; Menezes, M.S. Surface Topography, Gloss and Flexural Strength of Pressable Ceramic after Finishing-Polishing Protocols. *Braz. Dent. J.* **2019**, *30*, 164–170. [CrossRef] [PubMed]
13. Hamdy, T.M.; Abdelnabi, A.; Othman, M.S.; Bayoumi, R.E. Alterations in Surface Gloss and Hardness of Direct Dental Resin Composites and Indirect CAD/CAM Composite Block after Single Application of Bifluorid 10 Varnish: An In Vitro Study. *J. Compos. Sci.* **2024**, *8*, 58. [CrossRef]

14. Abdelraouf, R.M.; Moussa, T.A.; Hamdy, T.M.; Abuhaimed, R.A.; Alotaibi, A.M.; Jurado, C.A.; Alhotan, A.; Alhelal, B.; Habib, N.A. Effect of Ceramic Thickness and Technician Variability on the Shade Duplication of Dental Ceramo-Metallic Restorations. *J. Funct. Biomater.* **2024**, *15*, 12. [CrossRef]
15. Alshali, R.Z.; AlQahtani, M.A.; Bukhary, D.M.; Alzahrani, M.A.; Alsoraihi, S.S.; Alqahtani, M.A. The Effect of Bleaching on Surface Roughness and Gloss of Different CAD/CAM Ceramic and Hybrid Ceramic Materials. *J. Appl. Biomater. Funct. Mater.* **2023**, *21*, 1–9. [CrossRef]
16. Alrabeah, G.; Shabib, S.; Almomen, R.; Alhedeithi, N.; Alotaibi, S.; Habib, S.R. Effect of Home Bleaching on the Optical Properties and Surface Roughness of Novel Aesthetic Dental Ceramics. *Coatings* **2023**, *13*, 330. [CrossRef]
17. Ma, D.H.K.; Lai, J.Y.; Cheng, H.Y.; Tsai, C.C.; Yeh, L.K. Carbodiimide Cross-Linked Amniotic Membranes for Cultivation of Limbal Epithelial Cells. *Biomaterials* **2010**, *31*, 6647–6658. [CrossRef]
18. Alkurt, M.; Yesil Duymus, Z.; Yildiz, Ş. How Home Bleaching Agents Affect the Color and Translucency of CAD/CAM Monolithic Zirconia Materials. *Dent. Mater. J.* **2022**, *41*, 511–519. [CrossRef]
19. Habib, S.R.; Al Rashoud, A.S.; Safhi, T.A.; Almajed, A.H.; Alnafisah, H.A.; Bajunaid, S.O.; Alqahtani, A.S.; Alqahtani, M. Variations in the Shades of Contemporary Dental Ceramics: An In Vitro Analysis. *Crystals* **2021**, *11*, 1288. [CrossRef]
20. Elbishari, H.; Silikas, N.; Satterthwaite, J.D. Is Deterioration of Surface Properties of Resin Composites Affected by Filler Size? *Int. J. Dent.* **2020**, *2020*, 2875262. [CrossRef]
21. Elter, B.; Aladağ, A.; Çömlekoğlu, M.; Dündar Çömlekoğlu, M.; Kesercioğlu, A. Colour Stability of Sectional Laminate Veneers: A Laboratory Study. *Aust. Dent. J.* **2021**, *66*, 314–323. [CrossRef] [PubMed]
22. Gad, M.M.; Rahoma, A.; Al-Thobity, A.M.; ArRejaie, A.S. Influence of Incorporation of ZrO_2 Nanoparticles on the Repair Strength of Polymethyl Methacrylate Denture Bases. *Int. J. Nanomed.* **2016**, *11*, 5633–5643. [CrossRef] [PubMed]
23. Al-Kheraif, A.A.A. The Effect of Mechanical and Chemical Polishing Techniques on the Surface Roughness of Heat-Polymerized and Visible Light-Polymerized Acrylic Denture Base Resins. *Saudi Dent. J.* **2014**, *26*, 56–62. [CrossRef] [PubMed]
24. Paluszyński, J.; Slówko, W. Measurements of the Surface Microroughness with the Scanning Electron Microscope. *J. Microsc.* **2009**, *233*, 10–17. [CrossRef]
25. Van Pham, K.; Vo, C.Q. A New Method for Assessment of Nickel-Titanium Endodontic Instrument Surface Roughness Using Field Emission Scanning Electronic Microscope. *BMC Oral Health* **2020**, *20*, 240. [CrossRef]
26. Martelo, J.B.; Andersson, M.; Liguori, C.; Lundgren, J. Three-Dimensional Scanning Electron Microscopy Used as a Profilometer for the Surface Characterization of Polyethylene-Coated Paperboard. *Nord. Pulp Pap. Res. J.* **2021**, *36*, 276–283. [CrossRef]
27. Popescu, A.D.; Tuculina, M.J.; Diaconu, O.A.; Gheorghiță, L.M.; Nicolicescu, C.; Cumpătă, C.N.; Petcu, C.; Abdul-Razzak, J.; Rîcă, A.M.; Voinea-Georgescu, R. Effects of Dental Bleaching Agents on the Surface Roughness of Dental Restoration Materials. *Medicina* **2023**, *59*, 1067. [CrossRef]
28. Lee, Y.K.; Lu, H.; Oguri, M.; Powers, J.M. Changes in Gloss after Simulated Generalized Wear of Composite Resins. *J. Prosthet. Dent.* **2005**, *94*, 370–376. [CrossRef]
29. Zhang, L.; Yu, P.; Wang, X.-Y. Surface Roughness and Gloss of Polished Nanofilled and Nanohybrid Resin Composites. *J. Dent. Sci.* **2021**, *16*, 1198–1203. [CrossRef]
30. El-Rashidy, A.A.; Abdelraouf, R.M.; Habib, N.A. Effect of Two Artificial Aging Protocols on Color and Gloss of Single-Shade versus Multi-Shade Resin Composites. *BMC Oral Health* **2022**, *22*, 321. [CrossRef]
31. Bin Nooh, A.N.; Al Nahedh, H.; Alrefeai, M.; Alkhudhairy, F. The Effects of Irradiance on Translucency and Surface Gloss of Different Bulk-Fill Composite Resins: An in Vitro Study. *Clin. Cosmet. Investig. Dent.* **2020**, *12*, 571–579. [CrossRef] [PubMed]
32. Koizumi, H.; Saiki, O.; Nogawa, H.; Hiraba, H.; Okazaki, T.; Matsumura, H. Surface Roughness and Gloss of Current CAD/CAM Resin Composites before and after Toothbrush Abrasion. *Dent. Mater. J.* **2015**, *34*, 881–887. [CrossRef] [PubMed]
33. Sulaiman, T.A.; Abdulmajeed, A.A.; Donovan, T.E.; Ritter, A.V.; Vallittu, P.K.; Närhi, T.O.; Lassila, L.V. Optical Properties and Light Irradiance of Monolithic Zirconia at Variable Thicknesses. *Dent. Mater.* **2015**, *31*, 1180–1187. [CrossRef] [PubMed]
34. Egilmez, F.; Ergun, G.; Cekic-Nagas, I.; Vallittu, P.K.; Lassila, L.V.J. Estimation of the Surface Gloss of Dental Nano Composites as a Function of Color Measuring Geometry. *Am. J. Dent.* **2012**, *25*, 220–226.
35. Alhotan, A.; Abdelraouf, R.M.; Alhijji, S.; De Vera, M.A.T.; Sufyan, A.; Matinlinna, J.P.; Hamdy, T.M. Colour Parameters and Changes of Tea-Stained Resin Composite Exposed to Whitening Pen (In Vitro Study). *Polymers* **2023**, *15*, 3068. [CrossRef]
36. Wang, J.; Yang, J.; Lv, K.; Zhang, H.; Huang, H.; Jiang, X. Can We Use the Translucency Parameter to Predict the CAD/CAM Ceramic Restoration Aesthetic? *Dent. Mater.* **2023**, *39*, e1–e10. [CrossRef]
37. Labban, N.; Al Amri, M.D.; Alnafaiy, S.M.; Alhijji, S.M.; Alenizy, M.A.; Iskandar, M.; Feitosa, S. Influence of Toothbrush Abrasion and Surface Treatments on Roughness and Gloss of Polymer-Infiltrated Ceramics. *Polymers* **2021**, *13*, 3694. [CrossRef]
38. Aldosari, L.I.; Alshadidi, A.A.; Porwal, A.; Al Ahmari, N.M.; Al Moaleem, M.M.; Suhluli, A.M.; Shariff, M.; Shami, A.O. Surface Roughness and Color Measurements of Glazed or Polished Hybrid, Feldspathic, and Zirconia CAD/CAM Restorative Materials after Hot and Cold Coffee Immersion. *BMC Oral Health* **2021**, *21*, 422. [CrossRef]
39. Rosentritt, M.; Schneider-Feyrer, S.; Kurzendorfer, L. Comparison of Surface Roughness Parameters Ra/Sa and Rz/Sz with Different Measuring Devices. *J. Mech. Behav. Biomed. Mater.* **2024**, *150*, 106349. [CrossRef]
40. Taşın, S.; Ismatullaev, A.; Usumez, A. Comparison of Surface Roughness and Color Stainability of 3-Dimensionally Printed Interim Prosthodontic Material with Conventionally Fabricated and CAD-CAM Milled Materials. *J. Prosthet. Dent.* **2022**, *128*, 1094–1101. [CrossRef]

41. El-Rashidy, A.A.; Shaalan, O.; Abdelraouf, R.M.; Habib, N.A. Effect of Immersion and Thermocycling in Different Beverages on the Surface Roughness of Single- and Multi-Shade Resin Composites. *BMC Oral Health* **2023**, *23*, 367. [CrossRef] [PubMed]
42. Karatas, O.; Gul, P.; Gündoğdu, M.; Iskenderoglu, D.T. An Evaluation of Surface Roughness after Staining of Different Composite Resins Using Atomic Force Microscopy and a Profilometer. *Microsc. Res. Tech.* **2020**, *83*, 1251–1259. [CrossRef] [PubMed]
43. Çölgeçen, Ö.; Köse, M. Effects of Repeated Home Bleaching on the Surface Roughness of CAD-CAM Restoration Materials. *Int. Dent. Res.* **2022**, *12*, 143–148. [CrossRef]
44. Gheorghe, G.F.; Amza, O.E.; Dimitriu, B.; Garneata, L.; Suciu, I.; Moldovan, M.; Chisnoiu, R.M.; Prodan, D.; Chisnoiu, A.M. Comparative in Vitro Studies on the Effect of Bleaching Agents on Dental Structures in Healthy and Predialysis Patients. *Appl. Sci.* **2021**, *11*, 7807. [CrossRef]
45. Rodrigues Rangel, J.H.; Ferreira Zanatta, R.; Albuquerque, A.L.; Silva-Concílio, L.R.; Baroudi, K.; Mendes Tribst, J.P.; Amaral, M. The Effect of Bleaching Gel Application on the Physical Properties of Different CAD/CAM Restorative Materials. *J. Dent. Health Oral Disord. Ther.* **2022**, *12*, 41–44. [CrossRef]
46. Karadas, M. Efficacy of Whitening Oral Rinses and Dentifrices on Color Stability of Bleached Teeth. *Acta Biomater. Odontol. Scand.* **2015**, *1*, 29–34. [CrossRef]
47. Stawarczyk, B.; Liebermann, A.; Eichberger, M.; Güth, J.-F. Evaluation of Mechanical and Optical Behavior of Current Esthetic Dental Restorative CAD/CAM Composites. *J. Mech. Behav. Biomed. Mater.* **2016**, *55*, 1–11. [CrossRef]
48. Steinbrenner, H. Multichromatic and Highly Translucent Hybrid Ceramic Vita Enamic. *Int. J. Comput. Dent.* **2018**, *21*, 239–250.
49. Sonmez, N.; Gultekin, P.; Turp, V.; Akgungor, G.; Sen, D.; Mijiritsky, E. Evaluation of Five CAD/CAM Materials by Microstructural Characterization and Mechanical Tests: A Comparative in Vitro Study. *BMC Oral Health* **2018**, *18*, 5. [CrossRef]
50. Hamdy, T.M.; Abdelnabi, A.; Othman, M.S.; Bayoumi, R.E.; Abdelraouf, R.M. Effect of Different Mouthwashes on the Surface Microhardness and Color Stability of Dental Nanohybrid Resin Composite. *Polymers* **2023**, *15*, 815. [CrossRef]
51. Bakr, A.M.A.; Ghany, O.S.A.; Hameed, S.M.A. Effect of Different Surface Treatments on Translucency of Ultra Translucent Zirconia in Different Thicknesses. *Al-Azhar J. Dent.* **2023**, *10*, 23. [CrossRef]
52. Taher, H.; Abouauf, E. The Surface Gloss and Micro-Hardness of Two Recent Tooth Colored Restorative Materials After In-Office Bleaching. *Egypt. Dent. J.* **2019**, *65*, 513–521. [CrossRef]
53. Mörmann, W.H.; Stawarczyk, B.; Ender, A.; Sener, B.; Attin, T.; Mehl, A. Wear Characteristics of Current Aesthetic Dental Restorative CAD/CAM Materials: Two-Body Wear, Gloss Retention, Roughness and Martens Hardness. *J. Mech. Behav. Biomed. Mater.* **2013**, *20*, 113–125. [CrossRef] [PubMed]
54. Albani, R.; Habib, S.R.; AlQahtani, A.; AlHelal, A.A.; Alrabiah, M.; Anwar, S. The Surface Roughness of Contemporary Indirect CAD/CAM Restorative Materials That Are Glazed and Chair-Side-Finished/Polished. *Materials* **2024**, *17*, 997. [CrossRef]
55. Alhassan, M.; Maawadh, A.; Labban, N.; Alnafaiy, S.M.; Alotaibi, H.N.; BinMahfooz, A.M. Effect of Different Surface Treatments on the Surface Roughness and Gloss of Resin-Modified CAD/CAM Ceramics. *Appl. Sci.* **2022**, *12*, 11972. [CrossRef]
56. Jamwal, N.; Rao, A.; Mc, G.S.; Ramya Shenoy, K.; Bh, M.P.; Jodalli, P.; Ks, A.; Br, A. Effect of Whitening Toothpastes on the Surface Roughness and Microhardness of Human Teeth—An in Vitro Study. *Clin. Oral Investig.* **2023**, *27*, 7889–7897. [CrossRef]
57. Aydın, N.; Topçu, F.T.; Karaoğlanoğlu, S.; Oktay, E.A.; Erdemir, U. Effect of Finishing and Polishing Systems on the Surface Roughness and Color Change of Composite Resins. *J. Clin. Exp. Dent.* **2021**, *13*, 446–454. [CrossRef]
58. Gömleksiz, S.; Okumuş, Ö.F. The Effect of Whitening Toothpastes on the Color Stability and Surface Roughness of Stained Resin Composite. *BMC Oral Health* **2024**, *24*, 860. [CrossRef]
59. Yalcin, F.; Gürgan, S. Effect of Two Different Bleaching Regimens on the Gloss of Tooth Colored Restorative Materials. *Dent. Mater.* **2005**, *21*, 464–468. [CrossRef]
60. Eachempati, P.; Kumbargere Nagraj, S.; Kiran Kumar Krishanappa, S.; Gupta, P.; Yaylali, I.E. Home-Based Chemically-Induced Whitening (Bleaching) of Teeth in Adults. *Cochrane Database Syst. Rev.* **2018**, *2018*, CD006202. [CrossRef]